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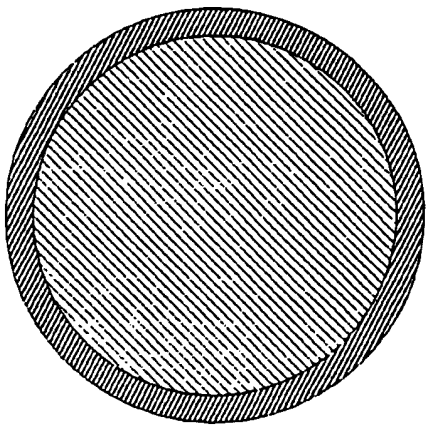
## (54) Coated microparticles with improved drug absorption.

(57) The preparation consists of millispheres, micro-spheres, nanospheres or array-type particles consisting of a nucleus of a gellable hydrocolloid onto which has been deposited a film of a cationic polysaccharide, and incorporating inside a pharmacologically useful drug. The procedure consists of dissolving, suspending or emulsifying the drug in a solution of the gellable hydro-colloid ; adding the resulting mixture to a gelling solution ; and suspending the resulting millispheres, micro-spheres, nanospheres or array-type particles in a solution of the cationic polysaccharide.

FIG. 1




EP 0 635 261 A1

The present invention relates to a new method and compositions for improving the absorption of drugs taken by the oral route by means of encapsulation in millispheres of gellable hydrocolloids covered with positively charged polysaccharides.

## BACKGROUND OF THE INVENTION

The oral route is preferred when administering drugs to all kinds of patients due to the advantages of this method relative to other routes which are more aggressive and/or more difficult to apply (intravenous, parenteral, subcutaneous...). Nevertheless, not all drugs are easily absorbed via the gastrointestinal tract. This absorption depends, among other factors, on the permeability of the gastrointestinal mucous membrane to the drug and on the acidic or enzymatic degratative processes to which the drug is subjected whilst it is inside the gastrointestinal tract. It is therefore clear that any factor which improves the speed of absorption of the drug or protects it from the above mentioned degradative processes will improve the clinical efficiency of that drug.

Recently a considerable amount of effort has been made to identify agents which are able to increase the permeability of the gastrointestinal mucous membrane to poorly absorbed products. Tensioactives (George, Sutter, Finegold, J. Infec. Dis. 136, 822 (1977), chellating agents (Cassidy, Tidball, J. Cell. Biol. 32, 672 (1967), salicylates (Higuchi, et al., U.S. Patent 4,462,991 (1984), anti-inflammatory agents (Yaginuma, et al., Chem. Pharm. Bull. 29 1974 (1961), phenothiazines (Alexander and Fix, U.S. Patent 4,425,357 (1984) acyl carnitines (Alexander and Fix, USSN 606, 054), fatty acids (Yamazaki, et al., J. Pharm. Pharmacol., 42, 441, (1990) have been described as able to increase gastrointestinal permeability to a large variety of compounds. Furthermore, considerable efforts have also been made to produce systems which protect drugs from the degradative gastrointestinal processes. Coverings of farinose (WO 89/11269), Polymers of lactic and glycolic acid (EP 0202159) and Calcium alginate (Chong-Kook K., Eun-Jin L., Int. J. Pharm., 79, 11, (1992), have been described as systems for administering drugs by the gastrointestinal route.

PCT WO 87/03197 describes microspheres which are less than 200 µm in size and which are obtained from a drug and a material that has ionic exchange properties, such as diethylaminoethyl-dextran.

PCT WO 88/090163, WO 89/032207, WO 91/02545 and WO 91/06282 describe microspheres which are less than 200 µm in size and whose centres are made of starch, starch derivatives, gelatine, albumen, collagen, dextran or dextran derivatives and which can optionally be covered by polymers such as alginates or diethylaminoethyldextrans among others. The use of such microspheres is always described with reference to application by routes other than the oral route and they can optionally be provided with absorption promoters such as lysolecithins or alginates.

EP 391803 describes an industrial procedure for obtaining capsules of alginates in a continuous process by a procedure which is itself described in previous literature (Grant, G.I., et al.; FEBS Lett. 32, 195 (1973).

PCT WO 92/00732 describes pellets of polysaccharides (in particular pectins) which are able to form coacervates with polyvalent cations, containing a drug and covered again by the same type of polysaccharide. These particles are administered by the oral route, the drug being liberated in the colon after the polysaccharide covering has been dissolved by bacteria.

## BRIEF DESCRIPTION OF THE INVENTION

The presence of a certain negative charge density on the surface of most gastrointestinal mucous membranes is known, and the authors therefore directed their research towards obtaining a system of administering drugs by the oral route consisting of millispheres with a certain degree of positive surface charge (covered with cationic polysaccharides) in order to achieve a bioadhesive effect on the surface of the gastrointestinal mucous membranes.

As a result of this research it was discovered, surprisingly, that when drugs which are difficult to absorb gastrointestinally are administered by the oral route incorporated inside millicapsules of gellable hydrocolloids reticulated with cationic polysaccharides, there is a marked increase in the bioavailability of said drugs, and that this increase in the bioavailability of the encapsulated drug relative to the bioavailability of the free drug is even greater if promoters of absorption via the mucous membranes are encapsulated together with the drug.

Therefore, one object of the present invention is to improve the bioavailability of drugs which are difficult to absorb when administered by the oral route by means of encapsulating the drugs inside matrices of gellable hydrocolloids whose surfaces are covered by cationic polysaccharides, optionally incorporating together with the drug products which are able to modify the permeability of the gastrointestinal mucous membranes to the drug which is encapsulated.

A further object of the present invention is a new system of administering drugs by the oral route consisting of millispheres, microspheres, nanospheres or array-type particles of salts of gellable hydrocolloids whose sur-

faces are covered by cationic polysaccharides, and incorporating a pharmacologically active drug.

A further object of the present invention is a new system of administering drugs by the oral route, consisting of millispheres, microspheres, nanospheres or array-type particles of salts of gellable hydrocolloids whose surfaces are covered by cationic polysaccharides, and incorporating a pharmacologically active drug together with one or several promoters of absorption via the mucous membranes.

A further object of the present invention is a new system of administering drugs by the oral route, consisting of millispheres, microspheres, nanospheres or array-type particles of salts of gellable hydrocolloids whose surfaces are covered by cationic polysaccharides, and incorporating a pharmacologically active drug wherein optionally, and in particular in the case of drugs which are sensitive to the chemical/enzymatic conditions of the stomach, said particles are administered inside capsules of gelatine with an enteric covering which protects the particles until they enter the duodenum.

These formulations have the inherent advantages of the oral route compared with other routes for administering drugs, i.e. they are easier to administer, more comfortable, less aggressive and safer for the patient.

Furthermore, the formulations claimed have the advantage of enabling the drugs incorporated to reach the circulatory system without being destroyed during their passage through the digestive tract, in addition providing a high degree of bioavailability of the drug administered.

## DETAILED DESCRIPTION OF THE INVENTION

The present invention comprises the preparation and use of millispheres, microspheres, nanospheres or array-type particles consisting of a nucleus or matrix of a gellable hydrocolloid onto which has been deposited a film of a cationic polysaccharide, the matrix of gellable hydrocolloid being able to incorporate one or several pharmacologically active drugs, and where optionally it is possible to incorporate together with the drug or drugs one or several promoters of absorption via the mucous membranes.

The incorporation of the drug inside the matrix of gellable hydrocolloid can be carried out principally in the following two ways:

1) - The drug is dissolved in the solution of the gellable hydrocolloid prior to the gelling thereof.

2) - The drug is incorporated by diffusion towards the hydrocolloid matrix from a concentrated solution of the drug, after the gelling of the matrix and before covering with the cationic polysaccharide.

Before continuing with the description of the present invention, reference is made to the accompanying drawings which are included in order that the invention may be better understood. In the drawings:

Figure 1 represents a millisphere consisting of a matrix of a gellable hydrocolloid which contains the drug and onto which has been deposited a covering film of a cationic saccharide, according to the present invention.

Figures 2 and 3 are flow diagrams of the method of incorporating the drug inside the matrix of gellable hydrocolloid by means of dissolving the drug in the solution of the gellable hydrocolloid prior to the gelling thereof.

Figures 4 and 5 are flow diagrams of the method of incorporating the drug inside the matrix of gellable hydrocolloid by the diffusion of the drug towards the matrix from a concentrated solution of the drug, after the gelling of the matrix and before covering with the cationic polysaccharide.

Gellable hydrocolloids is taken to refer to all polymers of biological or synthetic origin which are soluble in water and which can form solid gels by the cooling of their aqueous solutions, by interaction with the salts of metallic elements (more particularly the salts of alkaline-earth metals and more particularly calcium salts), by variations in the pH of their aqueous solutions, or by chemical reticulation. More particularly, gellable hydrocolloids is taken to refer to the following biopolymers: agar, pectin, xanthane gum, guar gum, locust bean gum, hyaluronic acid, casein and their mixtures, and even more particularly gellable hydrocolloids is taken to refer to the following biopolymers: water-soluble salts of alginic acid (more particularly sodium alginate), carrageenates and their mixtures.

Cationic polysaccharide is taken to refer to natural polysugars chemically functionalized with residues which can support a positive charge. More particularly cationic polysaccharides is taken to refer to the aminopolysugars and their acid salts, more particularly dextrans functionalized with primary, secondary, tertiary and/or quaternary amine groups, and even more particularly diethylaminoethyl-dextran and dimethylaminoethyl-dextran and their acid salts.

Promoters of absorption via the mucous membranes is taken to refer to all compounds capable of increasing the bioavailability of a drug when administered together with the drug by application to the nasal, gastrointestinal or vaginal mucous membranes or by the transdermic route. More particularly absorption promoters is taken to refer to the following groups of compounds:

- Esters of choline
- Chellating agents

- Salicylates
- Phenothiazines
- Acyl carnitins
- Alpha-cetoaldehydes
- Tensioactives
- Collates
- Lysolecithins

More particularly absorption promoters is taken to refer to lysolecithin and to the salts of fatty acids, in particular sodium caproate (sodium hexanoate), sodium caprylate (sodium octanoate), sodium caprate (sodium decanoate) and sodium laurate (sodium dodecanoate).

The drugs which can be incorporated in the new system for administering drugs which forms the object of the present invention include, but are not limited to, the following:

- Anti-bacterial drugs such as gentamycin; quinolones such as ciprofloxacin; penicillins or cephalosporins.
- Anti-viral agents such as rifampicin or acyclovir.
- Anti-fungal compounds such as anphoterecin B, myconazole, terconazole, econazole, isoconazole, thioconazole, biphonazole, clotrimazole, ketoconazole, butaconazole, itraconazole, oxiconazole, phenticonazole, nystatin, naphthyphene, zinoconazole, cyclopyroxolamine or fluconazole.
- Anti-parasitic compounds such as derivatives of antimony.
- Anti-tumoral and anti-neoplastic compounds such as adriamycin, vinblastine, vincristine, mitomycin C, doxorubicin, daunorubicin, methotrexate, cisplatin and others.
- Anti-metabolites.
- Proteins such as albumen.
- Toxins such as diphtheric toxin.
- Enzymes such as catalase.
- Peptides such as hirudin, somatostatin or timopentin.
- Hormones such as oestrogen.
- Peptide hormones such as human growth hormone, porcine growth hormone, bovine growth hormone, human calcitonin, salmon calcitonin, carbocalcitonin, insulin or LHRH and analogues.
- Hormonal antagonists.
- Neurotransmitters such as acetylcholine.
- Neurotransmitter antagonists.
- Glycoproteins such as hyaluronic acid.
- Lipoproteins such as alpha-lipoprotein.
- Immunoglobulins such as IgG.
- Immunomodulators such as interferon or interleukin.
- Immunosuppressors such as cyclosporin-A.
- Vasodilators.
- Colourings such as Arsenaze III.
- Radioactive labellers such as $^{14}C$.
- Radio-opaque compounds such aS $^{90}Te$.
- Fluorescent compounds such as carboxy-fluorescein.
- Cellular receptors such as oestrogen receptor protein.
- Non-steroidal anti-inflammatory agents such as indomethacin, ibuprofen, sulindac, diclofenac, ketorolac or naproxen.
- Anti-inflammatory agents such as dexametasone.
- Anti-glaucomatous agents such as pilocarpine or thymolol.
- Mydriatic compounds.
- Local anaesthetics such as lidocaine.
- Narcotics such as codeine.
- Vitamins such as alpha-tocopherol.
- Nucleic acids such as thymine.
- Polynucleotides such as RNA.
- Psychoactive or anxiolytic compounds such as diazepam.
- Mono-, di- and poly-saccharides such as glycogen.
- Glycosaminoglycanes such as non-fractionated heparins, heparins of low molecular weight, pentasaccharide, dermatan sulphate and its derivatives, heparan sulphate and its derivatives, chondroitin-4-sulphate or chondroitin-6-sulphate and its derivatives.
- Cardiovascular agents such as alpha-blockers, beta-blockers, calcium channel blockers, ACE inhibitors,

histamine H2 receptor inhibitors or serotonin H3T receptor inhibitors.

- Prostaglandins.

Optionally, and in particular in the case of drugs which are sensitive to the chemical/enzymatic conditions of the stomach, said particles are administered inside capsules of gelatine with an enteric covering which protects the particles until they enter the duodenum.

The invention is illustrated below by means of the following non-limiting examples of the scope of said invention.

EXAMPLE 1:

Obtaining capsules of calcium alginate covered with DEAE-Dextran incorporating sodium heparin of low molecular weight (SLMWH).

500 mg of SLMWH (4 kDaltons) are dissolved in 10 ml of 1% sodium alginate solution by shaking gently. The resulting solution is added drop by drop through a 0.8 mm hole to 40 ml of a gently shaken 0.25 M solution of $CaCl_2$ in $H_2O$. Once the addition of the millispheres is complete they are kept in the bulk of the shaken $CaCl_2$ solution for 10 minutes, after which time the balls are separated by filtering and washed with 25 ml of deionized $H_2O$.

The spheres of calcium alginate thus formed are resuspended in 20 ml of an 8% solution of diethylaminoethyl-dextran hydrochloride (Mr = 500000) in $H_2O$, keeping the system gently shaken for 30 minutes.

The spheres are separated by filtering, washed twice with 20 ml of deionized $H_2O$ and dried.

EXAMPLE 2:

Obtaining capsules of calcium alginate covered with DEAE-dextran incorporating sodium heparin of low molecular weight (SLMWH) and sodium caprate.

500 mg of SLMWH (4 kDaltons) and 200 mg of sodium caprate are dissolved in 10 ml of 1% sodium alginate solution by shaking gently. The resulting solution is added drop by drop through a 0.8 mm hole to 40 ml of a gently shaken 0.25 M solution of $CaCl_2$ in $H_2O$. Once the addition of the millispheres is complete they are kept in the bulk of the shaken $CaCl_2$ solution for 10 minutes, after which time the balls are separated by filtering and washed with 25 ml of deionized $H_2O$.

The spheres of calcium alginate thus formed are re-suspended in 20 ml of an 8% solution of diethylaminoethyl-dextran hydrochloride (Mr = 500000) in $H_2O$, keeping the system gently shaken for 30 minutes.

The spheres are separated by filtering; washed twice with 20 ml of deionized $H_2O$ and dried.

EXAMPLE 3:

Obtaining capsules of calcium alginate covered with DEAE-Dextran incorporating sodium heparin of low molecular weight (SLMWH). Method of encapsulation by diffusion.

10 ml of 1% sodium alginate solution are added through a 0.8 mm hole to 40 ml of a 0.25 M solution of $CaCl_2$. The system is kept shaken for 10 minutes.

The spheres formed are separated by filtering and washed with 25 ml of deionized $H_2O$, after which they are re-suspended in a solution of heparin, with a concentration of 100 mg/ml, and kept in the bulk of said solution and gently shaken for a period of 6 hours to allow the drug to diffuse inside the capsules. The capsules are then separated by filtering and washed three times with 25 ml of $H_2O$.

The spheres of calcium alginate incorporating SLMWH thus formed are re-suspended in 20 ml of an 8% solution of diethylaminoethyl-dextran hydrochloride (Mr = 500000) in $H_2O$, keeping the system gently shaken for 30 minutes.

The spheres are separated by filtering, washed twice with 20 ml of deionized $H_2O$ and dried.

EXAMPLE 4:

Obtaining capsules of calcium alginate covered with DEAE-Dextran incorporating sodium heparin of low molecular weight (SLMWH) and sodium caprate. Method of encapsulation by diffusion.

10 ml of 1% sodium alginate solution containing 2% sodium caprate are added through a 0.8 mm hole to 40 ml of a 0.25 M solution of $CaCl_2$. The system is kept shaken for 10 minutes.

The spheres formed are separated by filtering and washed with 25 ml of deionized water, after which they are re-suspended in a solution of heparin, with a concentration of 150 mg/ml, and kept in the bulk of said solution and gently shaken for a period of 6 hours to allow the drug to diffuse inside the capsules. The capsules

are then separated by filtering and washed three times with 25 ml of $H_2O$.

The spheres of calcium alginate incorporating SLMWH thus formed are re-suspended in 20 ml of an 8% solution of diethylaminoethyl-dextran hydrochloride (Mr = 500000) in $H_2O$, keeping the system gently shaken for 30 minutes.

The spheres are separated by filtering, washed twice with 20 ml of deionized $H_2O$ and dried.

EXAMPLE 5:

Bioavailability tests on the capsules prepared according to examples 1 and 2.

- Design:

  Bioavailability studies in which the animals received 40 mg of heparin by the oral route or 10 mg by the subcutaneous route over a period of three days.

- Animals:

  Four dogs (2 for each treatment), each approximately 15 kg in weight.

- Measurements:

  A bioassay (anti-Xa activity) was used to measure the concentrations in the plasma.

  The anti-Xa activity in the plasma was measured ex-vivo using a chromogenic test using a commercially available kit (Coatest) and expressed in IU/ml. The values were calculated from a calibration curve obtained in-vitro by adding different quantities of SLMWH to dog plasma.

  The blood was extracted from the femoral vein. Starting on the second day of experiments samples were collected before and 1, 2, 3, 4 and 6 hours after oral or subcutaneous administration, sodium citrate was added to the samples (9 vol. sangre : 1 vol. 3.8% sodium citrate) followed by centrifuging at 1200 rpm for 20 minutes at 4°C. The plasma was separated immediately and the anti-Xa activity was tested.

  The urine samples were treated with chondroitinase AC to eliminate the endogenous chondroitins. The residue was analyzed by means of proton NMR and HPLC (to determine the molecular weight).

- Results:

  Even on the second day of experiments, the levels of heparin in the blood as a result of administering SLMWH in the form of capsules by the oral route, or injected subcutaneously, were detectable using the anti-Xa activity method.

Comparable peak values (0.2 - 0.4 IU/ml) were found after subcutaneous or oral administration, as well as a significant continued activity (> 0.1 IU/ml) for 3 hours only after subcutaneous administration.

On the third day of experiments the basal values of anti-Xa activity before the final dose were significantly higher than the corresponding values on the previous day.

Peak values (0.8 - 1.2 IU/ml) were found 1 and 2 hours after oral and subcutaneous administration as well as a significant activity (> 0.3 IU/ml) after 6 hours in the case of both treatments.

The urine analyses gave the following results:

The $H_1$-NMR test detected the presence of partially disulphated heparin.

The HPLC test indicated a molecular weight of 5 kDaltons.

EXAMPLE 6:

Incorporation procedures for several drugs

| DRUG | GELLABLE HYDROCOLLOID | CATIONIC POLYSACCHARIDE | ABSORPTION PROMOTER | METHOD OF INCORPORATING THE DRUG |
|---|---|---|---|---|
| ACYCLOVIR | Sodium alginate | DEAE-Dextran | Lysolecithin | Example №2 |
| ACYCLOVIR HYDROCHLORIDE | Carrageenate | DEAE-Dextran | | Example №3 |
| CYCLOSPORIN | Sodium alginate | DEAE-Dextran | Sodium caprate | Example №2 |
| CYCLOSPORIN | Sodium alginate | DEAE-Dextran | | Example №1 |
| CALCITONIN | Sodium alginate | DEAE-Dextran | Lysolecithin | Example №2 |
| CARBOCALCITONIN | Sodium alginate | DEAE-Dextran | Sodium caprate | Example №2 |
| INSULIN | Sodium alginate | DEAE-Dextran | Sodium caprate | Example №2 |
| ERYTHROMYCIN | Sodium alginate | DEAE-Dextran | Sodium caprate | Example №1 |
| NIMODIPIN | Sodium alginate | DEAE-Dextran | | Example №2 |
| FLUCONAZOLE | Sodium alginate | DEAE-Dextran | Sodium caprate | Example №2 |
| CYPROFLOXACIN | Sodium alginate | DEAE-Dextran | Sodium caprate | Example №4 |
| FAMOTIDIN | Sodium alginate | DEAE-Dextran | Sodium caprate | Example №2 |
| KETOROLAC THROMETAMIN | Sodium alginate | DEAE-Dextran | Lysolecithin | Example №4 |
| DICLOFENAC | Sodium alginate | DEAE-Dextran | | Example №2 |

## Claims

1. A pharmaceutical preparation, characterized in that consists of dehydrated millispheres, dehydrated microspheres, dehydrated nanospheres or array-type dehydrated particles consisting of a nucleus of a gellable hydrocolloid onto which has been deposited a film of a cationic polysaccharide, and incorporating inside a pharmacologically useful drug.

2. A pharmaceutical preparation according to claim 1, characterized in that optionally said nucleus also incorporates a promoter of absorption via the mucous membranes.

3. A pharmaceutical preparation according to claims 1 and 2, characterized in that the gellable hydrocolloids are polymers of biological or synthetic origin which are soluble in water and which can form solid gels by the interaction with the salts of metallic elements (more particularly the salts of alkaline-earth metals and more particularly calcium salts) or by variations in the pH of their aqueous solutions or by chemical reticulation.

4. A pharmaceutical preparation according to claims 1, 2 and 3, characterized in that the gellable hydrocolloids are preferably agar, pectin, xanthane gum, guar gum, locust bean gum, hyaluronic acid, casein, water-soluble salts of alginic acid (more particularly sodium alginate), and their mixtures.

5. A pharmaceutical preparation according to claims 1 and 2, characterized in that the cationic polysaccharides are natural polysugars with residues which can support a positive charge and natural polysugars chemically functionalized with residues which can support a positive charge, in particular the amino-polysugars and their acid salts; dextrans functionalized with primary, secondary, tertiary and/or quaternary amine groups and their acid salts.

6. A pharmaceutical preparation according to claims 1, 2 and 5, characterized in that the cationic polysaccharides are preferably diethylaminoethyl-dextran and dimethylaminoethyl-dextran, their acid salts and their mixtures.

7. A pharmaceutical preparation according to claims 1 and 2, characterized in that the promoters of absorption via the mucous membranes are esters of choline, chellating agents, salicylates, phenothiazines, acyl carnitines, alpha-cetoaldehydes, tensioactives, collates, lysolecithins and their mixtures.

8. A pharmaceutical preparation according to claims 1, 2 and 7, characterized in that the promoters of absorption via the mucous membranes are preferably lysolecithin and salts of fatty acids, in particular sodium caproate (sodium hexanoate), sodium caprylate (sodium octanoate), sodium caprate (sodium decanoate) and sodium laurate (sodium dodecanoate).

9. A pharmaceutical preparation according to claims 1 and 2, characterized in that the drugs incorporated are:
   - Anti-bacterial drugs such as gentamycin; quinolones such as ciprofloxacin; penicillins or cephalosporins;
   - Anti-viral agents such as rifampicin or acyclovir;
   - Anti-fungal compounds such as anphoterecin B, myconazole, terconazole, econazole, isoconazole, thioconazole, biphonazole, clotrimazole, ketoconazole, butaconazole, itraconazole, oxiconazole, phenticonazole, nystatin, naphthyphene, zinoconazole, cyclopyroxolamine or fluconazole;
   - Anti-parasitic compounds such as derivatives of antimony;
   - Anti-tumoral and anti-neoplastic compounds such as adriamycin, vinblastine, vincristine, mitomycin C, doxorubicin, daunorubicin, methotrexate, cisplatin and others;
   - Anti-metabolites;
   - Proteins such as albumen;
   - Toxins such as diphtheric toxin;
   - Enzymes such as catalase;
   - Peptides such as hirudin, somatostatin or timopentin;
   - Hormones such as oestrogen;
   - Peptide hormones such as human growth hormone, porcine growth hormone, bovine growth hormone, human calcitonin, salmon calcitonin, carbocalcitonin, insulin or LHRH and analogues;
   - Hormonal antagonists;
   - Neurotransmitters such as acetylcholine;
   - Neurotransmitter antagonists;
   - Glycoproteins such as hyaluronic acid;
   - Lipoproteins such as alpha-lipoprotein;
   - Immunoglobulins such as IgG;
   - Immunomodulators such as interferon or interleukin;
   - Immunosuppressors such as cyclosporin-A;
   - Vasodilators;
   - Colourings such as Arsenaze III;
   - Radioactive labellers such as $^{14}C$;
   - Radio-opaque compounds such as $^{80}Te$;
   - Fluorescent compounds such as carboxy-fluorescein;
   - Cellular receptors such as oestrogen receptor protein;
   - Non-steroidal anti-inflammatory agents such as indomethacin, ibuprofen, sulindac, diclofenac, ketorolac or naproxen;
   - Anti-inflammatory agents such as dexametasone;
   - Anti-glaucomatous agents such as pilocarpine or thymolol;
   - Mydriatic compounds;
   - Local anaesthetics such as lidocaine;
   - Narcotics such as codeine;
   - Vitamins such as alpha-tocopherol;
   - Nucleic acids such as thymine;
   - Polynucleotides such as RNA;
   - Psychoactive or anxiolytic compounds such as diazepam;
   - Mono-, di- and poly-saccharides such as glycogen;

- Glycosaminoglycanes such as non-fractionated heparins, heparins of low molecular weight, pentasaccharide, dermatan sulphate and its derivatives, heparan sulphate and its derivatives, chondroitin-4-sulphate or chondroitin-6-sulphate and its derivatives;
- Cardiovascular agents such as alpha-blockers, beta-blockers, calcium channel blockers, ACE inhibitors, histamine H2 receptor inhibitors or serotonin H3T receptor inhibitors;
- Prostaglandins.

10. A procedure for obtaining the pharmaceutical preparation according to claim 1, characterized in that the drug is dissolved, suspended or emulsified in a solution of the gellable hydrocolloid; the resulting solution, suspension or emulsion is added to a medium in which the gelling of the hydrocolloid takes place (gelling solution); the millispheres, microspheres, nanospheres or array-type particles which are formed are separated and suspended in a solution of the cationic polysaccharide where the deposition of the cationic polysaccharide onto the surface of the spheres takes place, after which the covered spheres are separated, washed and dried.

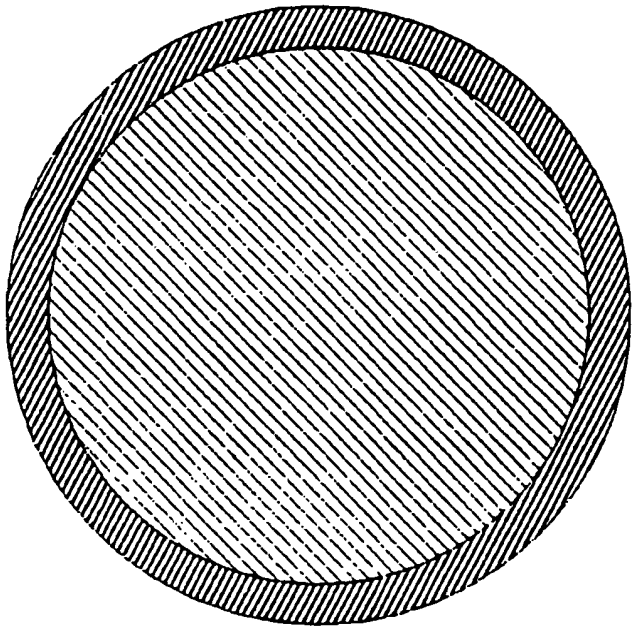
11. A procedure for obtaining the pharmaceutical preparation according to claims 1 and 2, characterized in that the drug and the absorption promoter are dissolved, suspended or emulsified in a solution of the gellable hydrocolloid solution; the resulting solution, suspension or emulsion is added to a medium in which the gelling of the hydrocolloid takes place (gelling solution); the millispheres, microspheres, nanospheres or array-type particles which are formed are separated and suspended in a solution of the cationic polysaccharide where the deposition of the cationic polysaccharide onto the surface of the spheres takes place, after which the covered spheres are separated, washed and dried.

12. A procedure for obtaining the pharmaceutical preparation according to claim 1, characterized in that the absorption promoter is dissolved, suspended or emulsified in a solution of the gellable hydrocolloid; the resulting solution, suspension or emulsion is added to a medium in which the gelling of the hydrocolloid takes place (gelling solution); the millispheres, microspheres, nanospheres or array-type particles which are formed are separated and suspended in a concentrated solution of the drug from which the drug diffuses inside the spheres; then the millispheres, microspheres, nanospheres or array-type particles are separated and suspended in a solution of the cationic polysaccharide where the deposition of the cationic polysaccharide onto the surface of the spheres takes place, after which the covered spheres are separated, washed and dried.

13. A procedure for obtaining the pharmaceutical preparation according to claim 1, characterized in that the solution of the gellable hydrocolloid is added to a medium in which the gelling of the hydrocolloid takes place (gelling solution); the millispheres, microspheres, nanospheres or array-type particles which are formed are separated and suspended in a concentrated solution of the drug from which the drug diffuses inside the spheres; then the millispheres, microspheres, nanospheres or array-type particles are separated and suspended in a solution of the cationic polysaccharide where the deposition of the cationic polysaccharide onto the surface of the spheres takes place, after which the covered spheres are separated, washed and dried.

14. A pharmaceutical preparation according to claims 1 to 9, characterized in that optionally, and in particular in the case of drugs which are sensitive to the chemical/enzymatic conditions of the stomach, said particles are administered inside capsules of gelatine with an enteric covering which protects the particles until they enter the duodenum.

FIG. 1



MATRIX

COATING

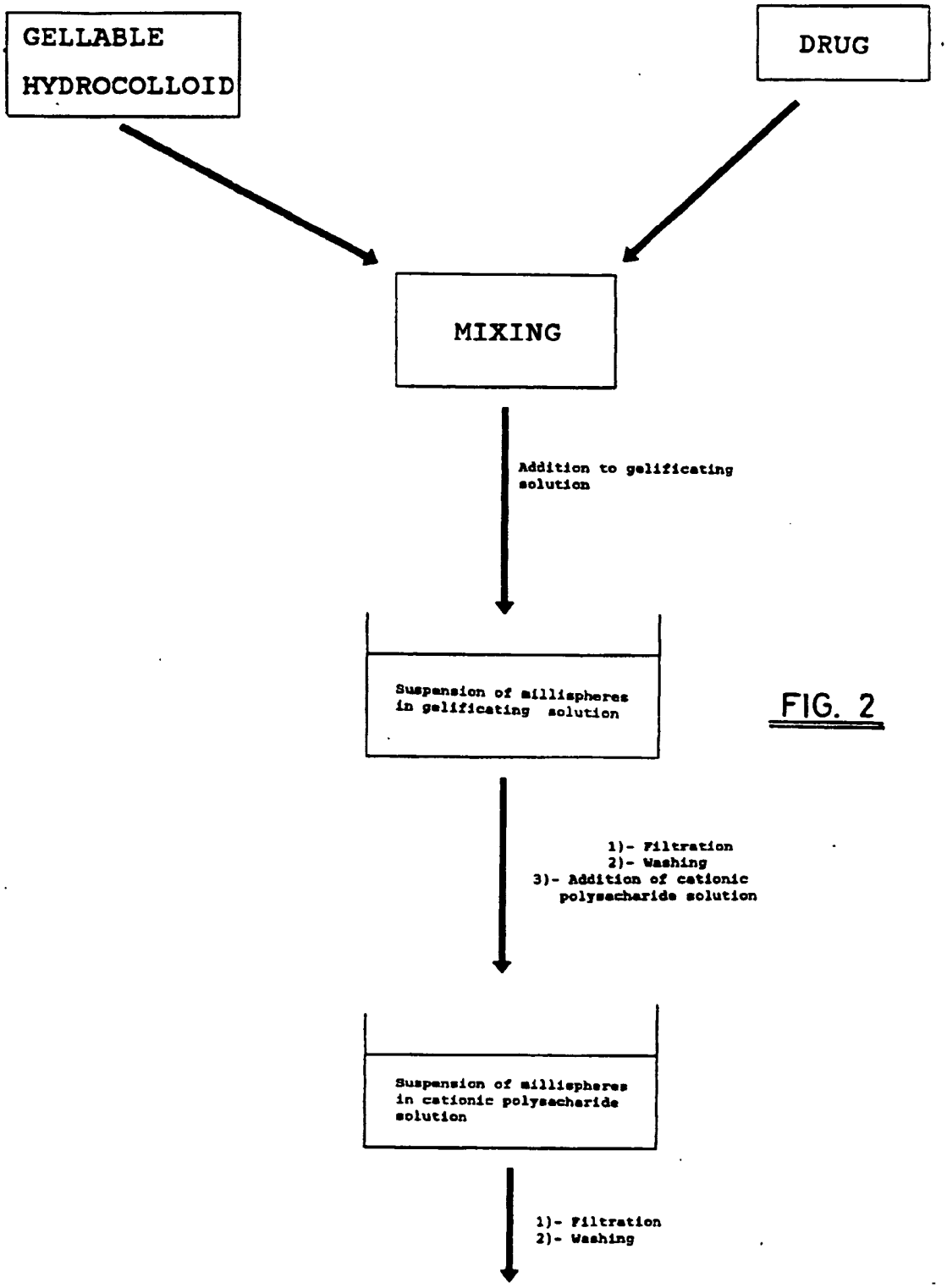

GELLABLE HYDROCOLLOID
DRUG
MIXING
Addition to gelificating solution
Suspension of millispheres in gelificating solution
1)- Filtration
2)- Washing
3)- Addition of cationic polysaccharide solution
Suspension of millispheres in cationic polysaccharide solution
1)- Filtration
2)- Washing
MILLISPHERES

FIG. 2

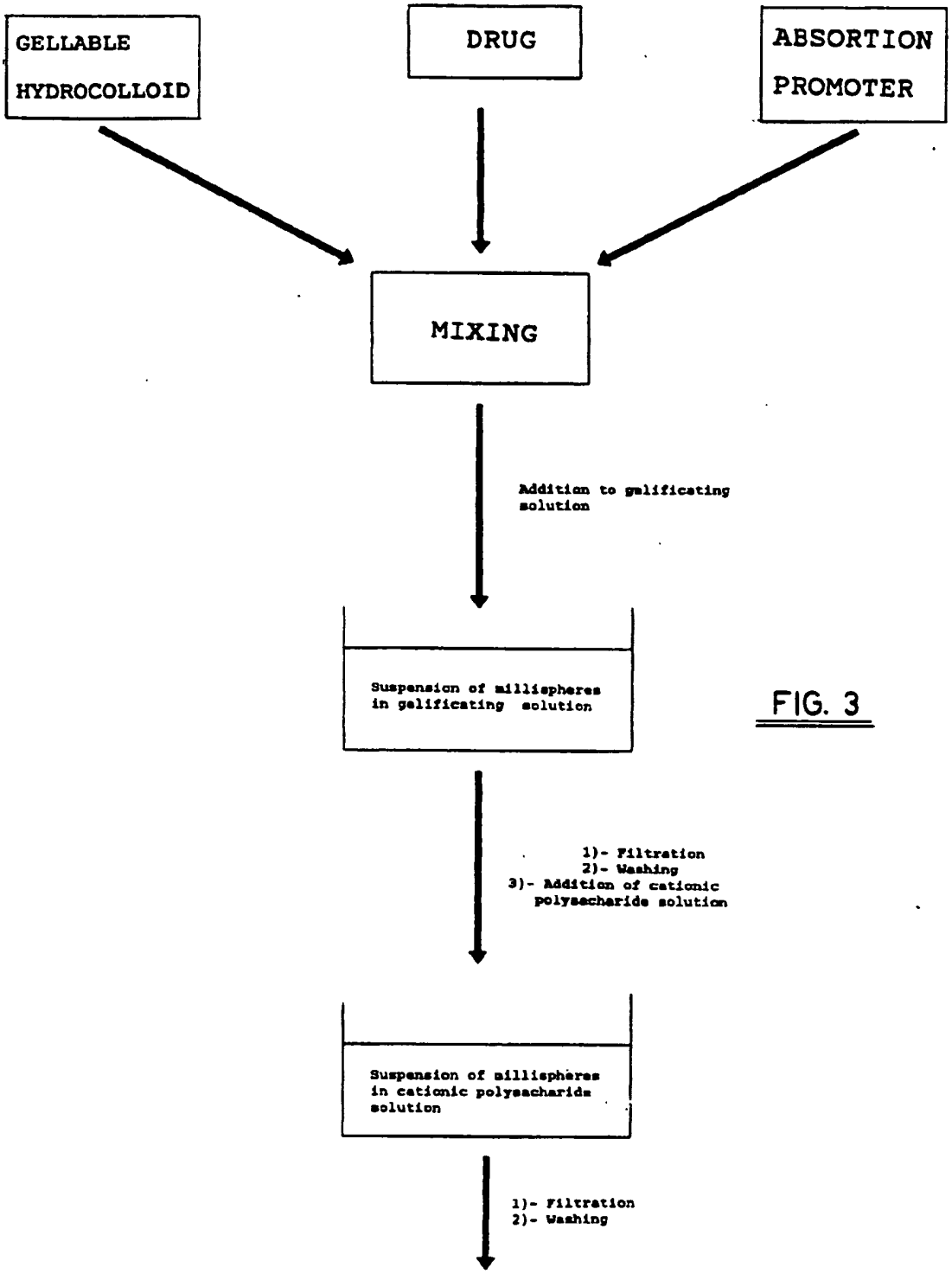

GELLABLE HYDROCOLLOID
DRUG
ABSORTION PROMOTER
MIXING
Addition to gelificating solution
Suspension of millispheres in gelificating solution
1)- Filtration
2)- Washing
3)- Addition of cationic polysaccharide solution
Suspension of millispheres in cationic polysaccharide solution
1)- Filtration
2)- Washing
MILLISPHERES

FIG. 3

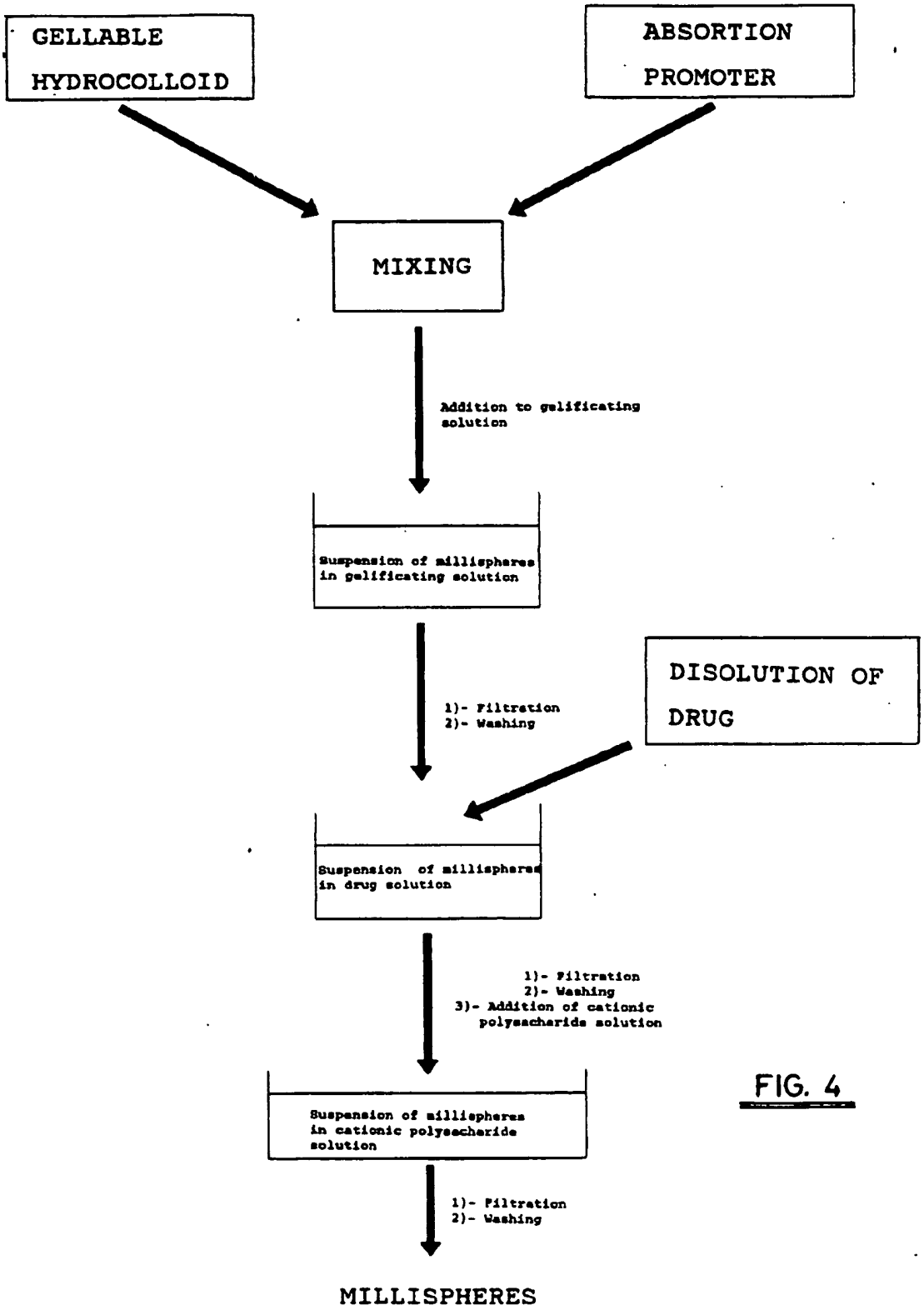

GELLABLE HYDROCOLLOID
ABSORTION PROMOTER
MIXING
Addition to gelificating solution
Suspension of millispheres in gelificating solution
1)- Filtration
2)- Washing
DISOLUTION OF DRUG
Suspension of millispheres in drug solution
1)- Filtration
2)- Washing
3)- Addition of cationic polysaccharide solution
Suspension of millispheres in cationic polysaccharide solution
1)- Filtration
2)- Washing
MILLISPHERES

FIG. 4

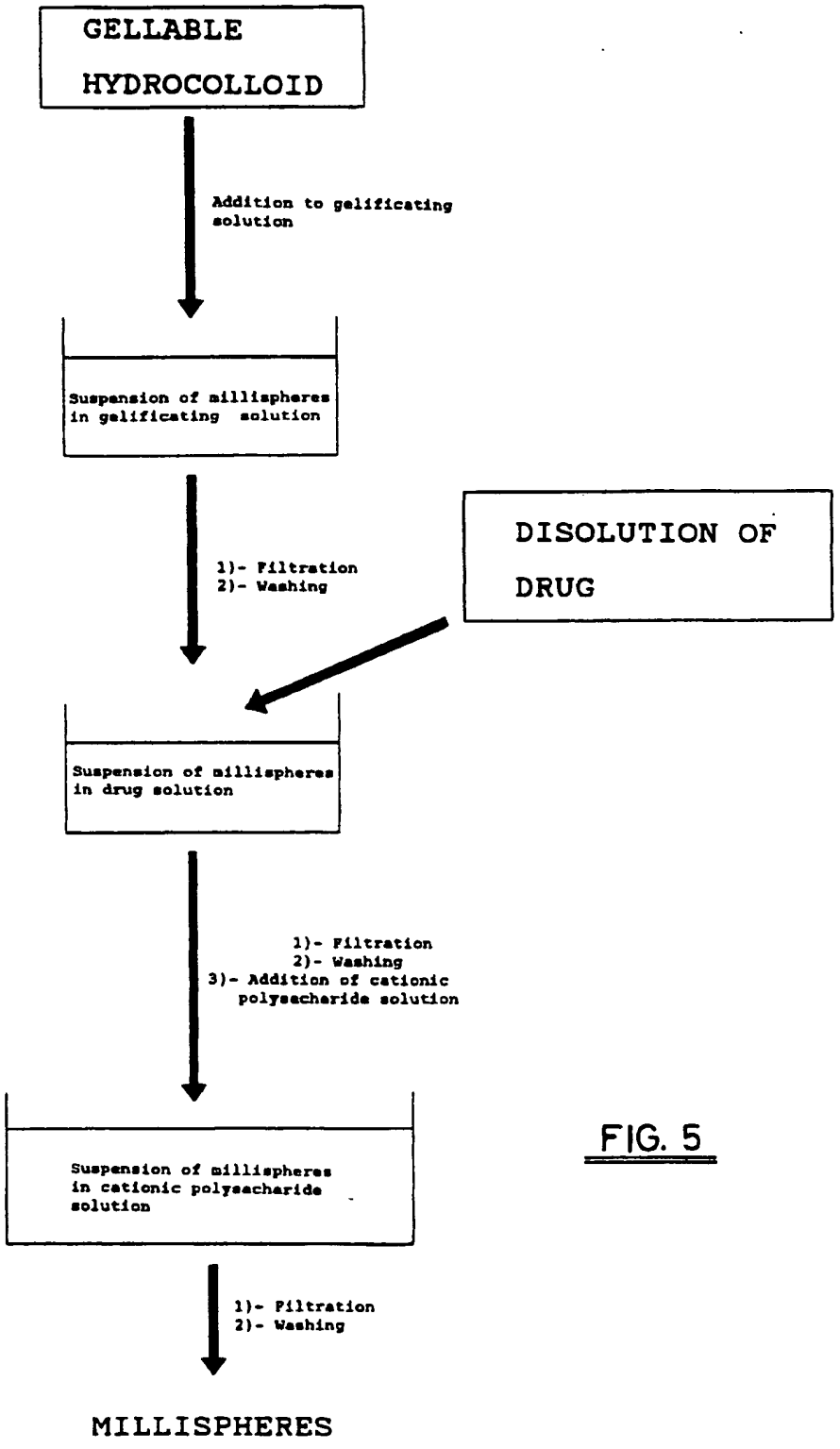

GELLABLE HYDROCOLLOID
Addition to gelificating solution
Suspension of millispheres in gelificating solution
1)- Filtration
2)- Washing
DISOLUTION OF DRUG
Suspension of millispheres in drug solution
1)- Filtration
2)- Washing
3)- Addition of cationic polysacharide solution
Suspension of millispheres in cationic polysacharide solution
1)- Filtration
2)- Washing
MILLISPHERES

FIG. 5

European Patent Office

# EUROPEAN SEARCH REPORT

Application Number
EP 94 50 0128

## DOCUMENTS CONSIDERED TO BE RELEVANT

| Category | Citation of document with indication, where appropriate, of relevant passages | Relevant to claim | CLASSIFICATION OF THE APPLICATION (Int.Cl.6) |
|---|---|---|---|
| X<br>Y | EP-A-0 301 777 (QUEEN'S UNIVERSITY AT KINGSTON)<br>* page 9 - page 10; example 7 * | 1,3-5,9, 10<br>2,6-8, 11-14 | A61K9/16<br>A61K9/50 |
| X<br>Y | EP-A-0 246 469 (HOECHST AG)<br>* the whole document *<br>* column 7; example 3 * | 1,3-5,9, 10<br>2,6-8, 11-13 | |
| D,Y | WO-A-91 06282 (DANBIOSYST UK LIMITED)<br>* the whole document *<br>* page 10, line 12 - line 17 *<br>* page 22, line 14 - page 23, line 6 * | 2,6-8, 11-13 | |
| D,Y<br>D,A | WO-A-92 00732 (KABI PHARMACIA AB)<br>* the whole document * | 14<br>1,3-5,9, 10 | |
| A | DATABASE WPI<br>Week 8620,<br>Derwent Publications Ltd., London, GB;<br>AN 86-127658<br>& JP-A-61 064 701 (MEITO SANGYO KK) 3 April 1986<br>* abstract * | 6 | A61K |

TECHNICAL FIELDS SEARCHED (Int.Cl.6)

The present search report has been drawn up for all claims

| Place of search | Date of completion of the search | Examiner |
|---|---|---|
| THE HAGUE | 28 October 1994 | Benz, K |

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& : member of the same patent family, corresponding document

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